

MAKER FAIRE 2006: 3D PRINTING ART

I'm a sculptor working with unusual geometries and high-tech manufacturing methods, and this is a roundup of some ways I've found to use 3D printing to make art. It's mainly focused on how to get good bang for the buck – there's no free way to do this kind of work, but there are lots of choices, and some are definitely cheaper than others. What's important is to pick the most economical way that will work for your project.

Warning

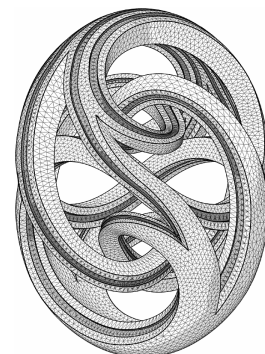
3D printing isn't better than injection molding, whittling, origami, machining, lost-wax casting, or gluing toothpicks together. It's more expensive, and the quality probably isn't as good, and if you can make what you want by any other means, you should probably do it. Think of 3D printing as the last resort, when you've dreamed up something that is flat-out impossible to make by conventional methods. My site (bathsheba.com) is one place to see some examples along those lines – impossible ideas are the only kind I have.

Another warning: it's probably too soon to buy a 3D printer. The technology's still raw and things are changing very fast, and although prices are coming down year on year, for my money it's still more expensive than it's worth. Wait for the \$1000 desktop box, is my advice.

Making a Model

To start you need a virtual 3D model, which is usually made using CAD modeling software. The file format to use is STL, which almost every 3D app can export. For a modeler I like Rhinoceros (rhino3d.com), but at \$600 it's not exactly cheap. Silo (nevercenter.com) is cheap. Blender (blender3d.org) is free. There's lots of others, from free to wildly expensive. Special note for programmers: the STL file format is simple and public, and if you want to roll your own sculpture algorithm, it's not hard to code this format from scratch.

However you make it, your model should be something that can be built: not infinitely thin or fantastically fragile or self-intersecting or anything else that physical objects can't be. Put it on your monitor blown up to life size, spin it around, and ask yourself honestly: can this thing exist in real life? 3D printing does amazing things, but it doesn't do magic.



Getting 3D Prints

Once you've got a model, the next steps are to choose a 3D printing process, get some quotes from service bureaus that run that process, then get your model printed. Usually you email the STL file to the service bureau, and they Fedex you the part. (If they know you don't need it overnight, you might get a better deal.) There are many choices of both process and service; here are some that I've used and come back to.

Z Corporation (zcorp.com)

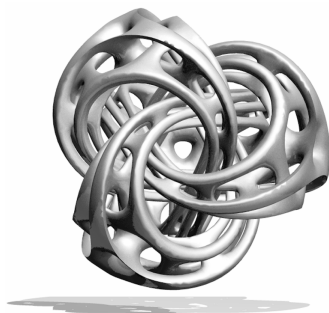
This is the place to start, it's by far the cheapest date. Make your mistakes and test parts in this process, then move on. ZCorp models aren't too strong and have a rough surface, but did I mention they're cheap? They come in two flavors: cornstarch (which can be burned out for lost-wax casting) and plaster (which can't). Most service bureaus only run plaster. The maximum size is 8 x 8 x 10", and the smallest useful part in this process would be about 2". My favorite source is 3Darttopart.com: at \$40-100 for most parts, they're hard to beat.

Stereolithography (3dsystems.com)

"SLA" for short. The oldest and most famous kind of 3D printing, this is the middle of the road. There are many machines that do this (Viper and Invision are two models), and they all make things out of more or less translucent plastic, pretty strong, with a smoother surface than ZCorp models but not polished. The parts usually get some hand sanding as part of the build service. Sizes are tiny to huge (24"), but it gets expensive fast once you're over a few inches. For a moderate-size object, expect to pay in the low \$00's. There are innumerable vendors for this type of process, so I recommend checking a broker for quotes (xpress3d.com is one). Two vendors I like: aproto.com and m2-systems.com.

Selective Laser Sintering (3dsystems.com)

SLS is the most expensive method I've used. The parts are made of strong opaque plastics, any size, and they come in different colors and formulations: white or black plastic,





aluminum-filled gray, even a sexy black carbon-fiber material. Again sizes range from small to large, with cost scaling up sharply. These parts are good enough quality that they look like products not prototypes – I've designed some high-end lamps that are directly manufactured this way. I favor solidconcepts.com as a vendor for this type of part, but again, get quotes from several places before forking over.

Jewelry-Size

For tiny high-resolution prints, there's a whole different set of options. If you need the model to be directly castable, good choices are green wax models made on Solidscape machines, or purple waxlike models made on Invision HR machines. If you just need a mold master, orange Perfactory models may be a good choice. All these processes offer very high (.001-4") resolution, but the sizes top out at about 1 inch. There are lots of service bureaus, Gemvision.com has a good list; I like A3DM.com for Solidscape or Perfactory parts. Two places that do model building PLUS silver or gold casting are 3dfactoryusa.com and bestcast.com. This is a very cool service: you send a file and get back precious metal. Warning: the castings will be raw, so you'll need some jewelry tools (or a friendly local jeweler) to polish them up.

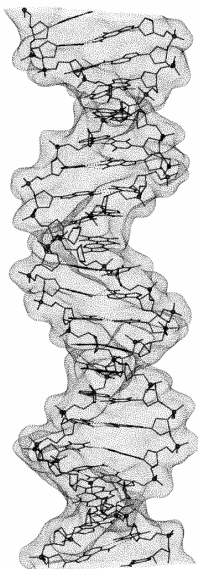
Direct Metal

Hate casting? I did. There are several different ways to 3D print in metal, of which the one I know well is Prometal.com. The good: they can print steel or steel/bronze directly, making uncastable shapes with no fuss at all, at costs competitive with lost-wax casting. I pay \$50 to \$400 apiece for my work depending on size. The bad: they have a \$500 minimum to get started. The ugly: parts have a heavy texture, similar to ZCorp's. Possibilities for dealing with it include postmachining, hand finishing, or just living with texture. (A serious downside is that you can't directly print machines with moving parts, as you can with the better grades of SLA. We're waiting!)



Learning More

The most important thing about 3D printing technologies and services is that there's a lot of them, all different, more springing up every year, and it pays to do the homework before spending money. A good place to find out more is the "Worldwide Guide to Rapid Prototyping" (Google for it), it has tons of information and an excellent service bureau directory.



Laser Etching

Lastly, I'll say a word about subsurface laser etching in glass. You've probably seen this: lots of gift shops have glass cubes with a goldfish or the Eiffel tower or something etched inside them, and there are franchise stores where you can get your face scanned and burned into a cube. But the technology is more interesting than these uses would suggest – it's a way to draw freely in physical 3D, and there aren't many of those. I've been using it to make scientific images as well as sculpture: astronomical data, proteins, math objects...any kind of data that's hard to image because it has complex 3D structure. There's any amount of untapped possibility here.

The etching is done by using a focused laser to create tiny fractures inside a blank piece of glass. The laser makes pin-shaped marks about .1mm in size, and they can be spaced about the same distance apart. However it's necessary to regulate the density intelligently, as it's quite possible to crack the glass by making too many marks too close together.

The basic file format for this medium is simply a list of X Y Z point coordinates, and if you feel like trying it, the vendor I favor is precisionlaserart.com. They run both high and low-frequency lasers, where the low-freq ones make bigger marks, with lower resolution, at cheaper prices. Cost is generally moderate, under \$100 per piece for most glass sizes, but be prepared to break some glass – like any other art medium, it takes some practice to get handy.

Thanks

Glad you made it to the first Maker Faire, and I hope you've enjoyed this whirlwind tour of the technologies I use for making sculpture. If you'd like to learn more, there's information at my site, bathsheba.com. There are also some free sculpture models available for download and building. I take an open-source view of the work, looking forward to a world where 3D printing is cheap and high-quality, and sculpture will be downloadable just as music is now. Hope to see you there!

— *Bathsheba Grossman*